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Reducing human work load using robotics with a combination of AI-IoT technologies for multiple domains

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Abstract - The fast growth of robotics and advanced automatic machines are reducing labour work in multiple domains. There are many progressive technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and Robotics are being introduced for performing tasks at particular domains, which reduces the use of systems at present time situations. As we see the demand for an intelligent system is increasing across various sectors, there is a need for an advanced system which will help to reduce human effort. Most of the current executing systems are present, but their way of adaptability is limited to a specific domain, which limits their work in other domains. In this investigation the technologies like AI will help to make decisions, and control the way of working of the robot. IOT sensors will gather the real time data collection, while the robotic system will perform the physical tasks through the software instructions/parameters. In the current situation the hardware and software are not integrated, they are dedicated to a particular domain. Due to this the main purpose of this research is to replace the software parameters instead of changing the complete hardware. Through this framework we can perform tasks in various domains such as industry, healthcare, agriculture, social services and disaster-prone areas. Therefore, we have designed a unified AI-IoT-Robotics proposed system for flexible and scalable work, which reduces human involvement across multiple domains. It will also help the future researchers, academicians and even technicians for the development of intelligent system which will work across multiple sectors.

Keywords - Artificial Intelligence (AI), Internet of Things (IoT), Robotics, Multi-Domain Framework, Human Effort Reduction, Parameter-Adaptive System, Intelligent Automation

1. INTRODUCTION

In the era of advanced technology and automation machines, new technologies are being introduced across various sectors. Intelligence systems are rapidly growing in areas like agriculture, industry, social services, healthcare, and also in the disaster-prone areas which provide productivity and consistency. Among most of these technologies like AI (Artificial intelligence), IoT (Internet of Things) and robotics plays a very important role in establishing data time collection, making decisions and physical task execution [12]. The IoT system enables interconnected devices to communicate effortlessly, creating intelligent systems that support real time monitoring as well as automation [4],[5]. Except for these advanced technologies many of the operational systems still require human physical work in hazardous, repetitive and labour-related tasks. Recently many of the studies highlight the increasing adaptation of AI-IOT-Robotic systems in agriculture and industrial applications. The advanced automation systems are present but they require human involvement for performing manual and decision-making tasks. Due to the absence of the unified integrated system, it lacks adaptability in multiple applicating areas.

Intelligent robots are equipped with AI for performing tasks effectively leading to development of AI- driven modules for multiple domains [10], [11]. Many systems lack scalability and flexibility thus making it difficult for overall domains. However, executing systems are present for specific-domains and this lacks their capacity for cross domain adaptation. For specific domains such as air-pollution detection and chemical composition analysis the IoT based sensors contribute to a safe and smart ecosystem [9],[10]. Most of the system cannot adapt to a new domain by completely changing the hardware or redesigning the whole system. Even if the system is present, human dependency is needed for task execution and decision making. but due to lack of flexibility, they have separate compartments which reduces the efficiency and coordination of the system. Currently many solutions are present but they are not effective across many domains. Using different robots for different domains increases maintenance, cost and resource consumption. The evolution of IoRT has enabled it to operate collaboratively within domains (healthcare, education, smart cities) [18], [20].

In order to adapt this in the modern world the main objective of this paper is to reduce the human work load. It not only improves productivity but also enhances sustainability and

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operational safety. Cloud robotics enhances robotic abilities by providing computational resources, scalable storage that allows robots to perform heavy processing tasks [7],[8]. This growing field demands the intelligence automated framework that will enhance support for human activities among various domains. This paper helps to create a framework that will work across multiple domains. This framework will have a unified integrated technologies that will work in various domains (Industry, Healthcare, Agriculture, social services, education and in the disaster-prone areas). Also, this proposed system can adapt in the environment. Human error will be reduced by using this technology. To support efficient communication and intelligent decision making with the help of IoRT (internet of robot things) environment [1],[19] In this work, the act of lowering the cost of a system by making an integrated module that can be redesigned instead of changing the entire system. This will help to create efficiently, work scalability, accuracy and also increase the speed of tasks.

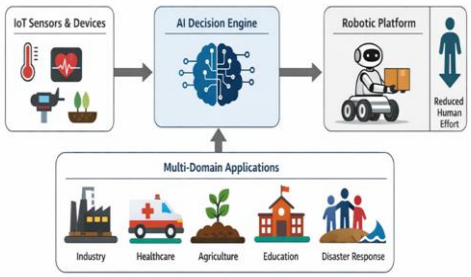

Figure 1: Conceptual Overview of the Unified AI-IoT-Robotics Framework for Cross-Domain Human Effort Reduction

As the figure1: shows the overview of this proposed system, it contains the advancement of technologies like AI-IoT-Robotics. Machine Intelligence/AI will help us for determining tasks and also for controlling the system. While the smart sensors will help to detect the real time record of the environment, the Automated robot will perform all the physical tasks. This framework will work in many fields by having a single integrated system for various domains

These frameworks will help in reducing human workload across various domains. One single framework will also help to reduce the cost for multiple systems by having a single integrated system. The IoRT will enhance the operational work and real time decision making will work efficiently. This innovative solution will support reliable communication, efficient data processing and also helps to sustainably deploy an intelligent robotic system.

2. METHODOLOGY

This research is based on conceptual and system-oriented methodology for reduced human work load across multiple domains using the combined framework of Ai-IoT-Robotics. This methodology brings architecture of modular design, task adaptation from software instruction and human-centric automation. The single robot can perform multiple tasks in different environments/domains without changing hardware modification.

The research is framework-based, which combines architectural modelling with scenario-based evaluation. Rather than focusing on domain-specific applications, the research work focuses on the integration of Ai (Artificial Intelligence), IoT(Internet of Things), and Robotics into a single system that can operate in any domain. The scope of research focuses on mainly primary domain and secondary domain. In the primary domain such as industry , agriculture and social service this proposed system will completely replace human repetitive workload . While Secondary domain (healthcare, disaster prone area) helps humans to perform tasks efficiently and reduce time consumption without replacing humans.

The proposed system is structured into a three-layer architecture consisting of:

1. IoT Sensing Layer IoT sensing layer
2. AI Decision-Making Layer
3. Robotic Execution Layer

These layers operate in a continuous feedback loop, allowing real-time sensing, intelligent decision-making, and autonomous task execution. A Domain Adaptation Module is integrated into the architecture to configure system behaviour based on the active application domain.

Following are the execution of the unified system: -

2.1 IoT Data Acquisition: The IoT acquisition layer is responsible for collecting data from their surroundings, like healthcare, agriculture and environment. The collected data is transmitted continuously to the Ai processing module through a network of communication. This real-time monitoring reduces the need for constant human observation and allows the system to respond quickly to changing conditions.

2.2 AI-Based Decision-Making Process: The AI based decision making process gets data from various sensors and makes decisions accordingly to the data. This AI based system can assume the rule of logic and simple or basic machine learning techniques to perform tasks and ensure safe operation and work.

2.3 Robotic Task Execution: The robotic execution layer engages in physical actions according to the instructions provided by the AI module. Robots are capable of doing mobility and functioning tasks to perform work.

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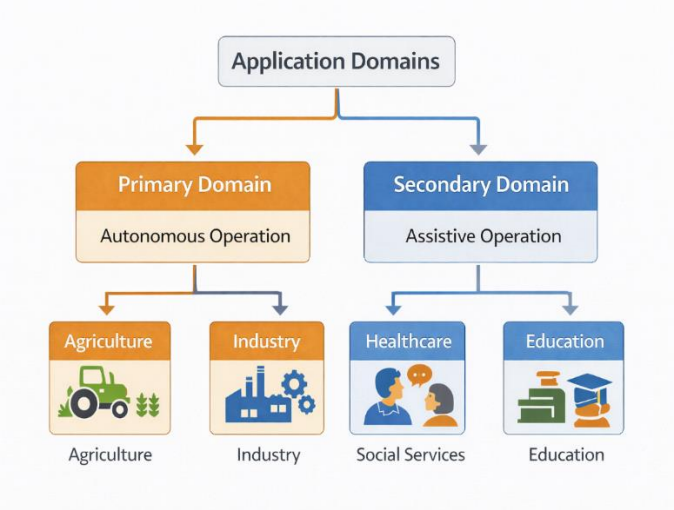
2.4 Domain Adaptation Strategy: It is composed of a software-based domain adaptation strategy that enables the robot system to function within different domains. Each domain is associated by a configuration profile that contains operational rules, safety constraints, and task parameters.

2.5 Evaluation Methodology: The evaluation of the proposed framework is conducted using a scenario-based analysis. Detailed workflows are created for primary domains such as industry, healthcare, and agriculture to demonstrate system functionality. Secondary domains, including education, social services, and disaster response, are evaluated using conceptual use cases to show adaptability.



2.6 Methodology Summary: This methodology combines IoT-based sensing, AI-driven decision-making, and robotic task execution in a single unified and modular domain. The software-defined domain adaptation mechanism enables a single robot to operate across multiple sectors. The feasibility and scalability of the proposed research is to reduce human effort.

3.LITERATURE REVIEW: -

Many research papers have discovered the integration of IoT and robotics to enhance the advancement of automation technologies. Gubbi et al. [4] and Atzori et al. [5] have presented foundational IoT architectures that configure smart connectivity for several devices. Zanella et al. [6] took this enlarged vision towards the smart city applications. Cloud robotics have also emerged for intelligent robotic systems it serves as a key enabler for integrating robotic automation. Kehoe et al. [7] and has discussed the advantages of cloud-based automation. While the Hu et al. [8] has mainly highlighted the architectural challenges and even the scalability considerations.

Kunze et al. [10] have examined AI techniques and support the long-term robot autonomy. While the theoretical foundations for the intelligence decision-making process have been briefly explained by Russell and Norvig [11]. In this advanced era the concept of IoRT (internet of robotic things) has been significantly integrated in various areas. Ray [18] has significantly described the core technologies and challenges with IoRT. AI-Turjman and Imran [20] have opened research issues including the cross-platform functionality and also the system integration. In today's world there is a need for environmental monitoring across multiple domains. IoT sensors help to improve data collection and analyse the real condition by studying air pollution sensing and chemical based environment [9],[14]. Many industries have supported smarter decision on pollution by applying AI technology [15]

The role of AI has significantly expanded in emerging research papers across multiple domains like industry, healthcare and education, which highlighted the need for scalable and adapted intelligent systems [13],[14],[17]. Among all of these studies provide theoretical and technologies foundations, they lack persistent limitations in computing efficiency, flexibility and scalable robot and reliable communication with the unified integrated multi domain robot environment.

4 PROBLEM STATEMENT:-

Many of the significantly progress in IoT, AI and robotics and even the current Internet of robotic things has faced several challenges

Modern automation technologies like Artificial Intelligence (AI), Internet of things (IoT) and Robotics are incapable of making real-time processing without cloud support [18]. These techniques are significantly improving in healthcare, agriculture, industries and multiple sectors. However, this automation is not capable of doing multiple work in various sectors [9]. For various sectors we have to use individual software and hardware which can increase development cost, resources and increase e-waste.

In a real-world scenario, human workers are still required to do repetitive and hazardous tasks due to the absence of automation technology systems. Ai enables systems often struggling to manage flexibility and more power usage making it for particular domains [11]. The current automation robots also need hardware upgradation and modification or completely redesigning for large software and interconnected networks [20] for performing tasks in multiple domains. Making them inefficient and incapable of cross domain work.

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There is a strong need for a system that can make independent/self-decision, adapt to various domains to perform tasks without complete redesign and modification.

5 BENEFITS: -

- Reduce human efforts by automating repetitive and physically demanding tasks.
- Reduce human exposure to dangerous environments such as disaster zones, polluted industries, and risky conditions in agriculture.
- Enhance the accuracy and consistency work compare to manual work
- Provide a single robot automation to operate/work in various domains without hardware modification.
- Reduce overall system cost by avoiding redesign and modifications for different sectors.
- Promotes smart automation by integrating the IoT sensors and Artificial intelligence (AI) in one system.
- Flexible for future use in new domains.

6. CONCLUSION

This research presented a unified AI-IoT-Robotics framework to reduce human physical efforts across multiple domains. This proposed system integrated with IoT based sensors for real-time data collection, Ai for decision making or planning the task execution, and robotics for physical task execution. Unlike previous/traditional automation systems that are limited to specific sectors or domains, the above proposed framework is advanced and software based work adaptation, giving a single robotic system to operate across industry, healthcare, agriculture, education, social services and disaster-prone areas.

The proposed combined system can help improve work efficiency, reduce repetitive manual tasks and keep people safe by lowering their contact to dangerous environments. Since the robot can work in different domains without changing hardware, the system becomes more cost-effective and flexible for performing tasks. Overall, this research shows that combining Artificial Intelligence (AI), Internet of things (IoT), and robotics can create a smart and adaptable solution for real-world problems and support future automation development also.

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